Possible ring structure for EDM measurements

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- need to
  cancel g-2 precession, or
  resonate with g-2
- g-2 frequency should be the same for all particles
- average magnetic field B independent of radius
- momentum compaction factor
  alpha = dR/dp = 1
  (as in a uniform magnetic field)
- BUT ..... we still need to focus the particles
- consult the experts ..... it can't be done

Ring design

Momentum compaction factor $\alpha = dR / dp = 1$

Well-known formula $\alpha = 1 / Q_h^2$

Courant & Snyder, Annals of Physics (1958)

Example: weak focusing $Q_h = \sqrt{(1 - n)}$

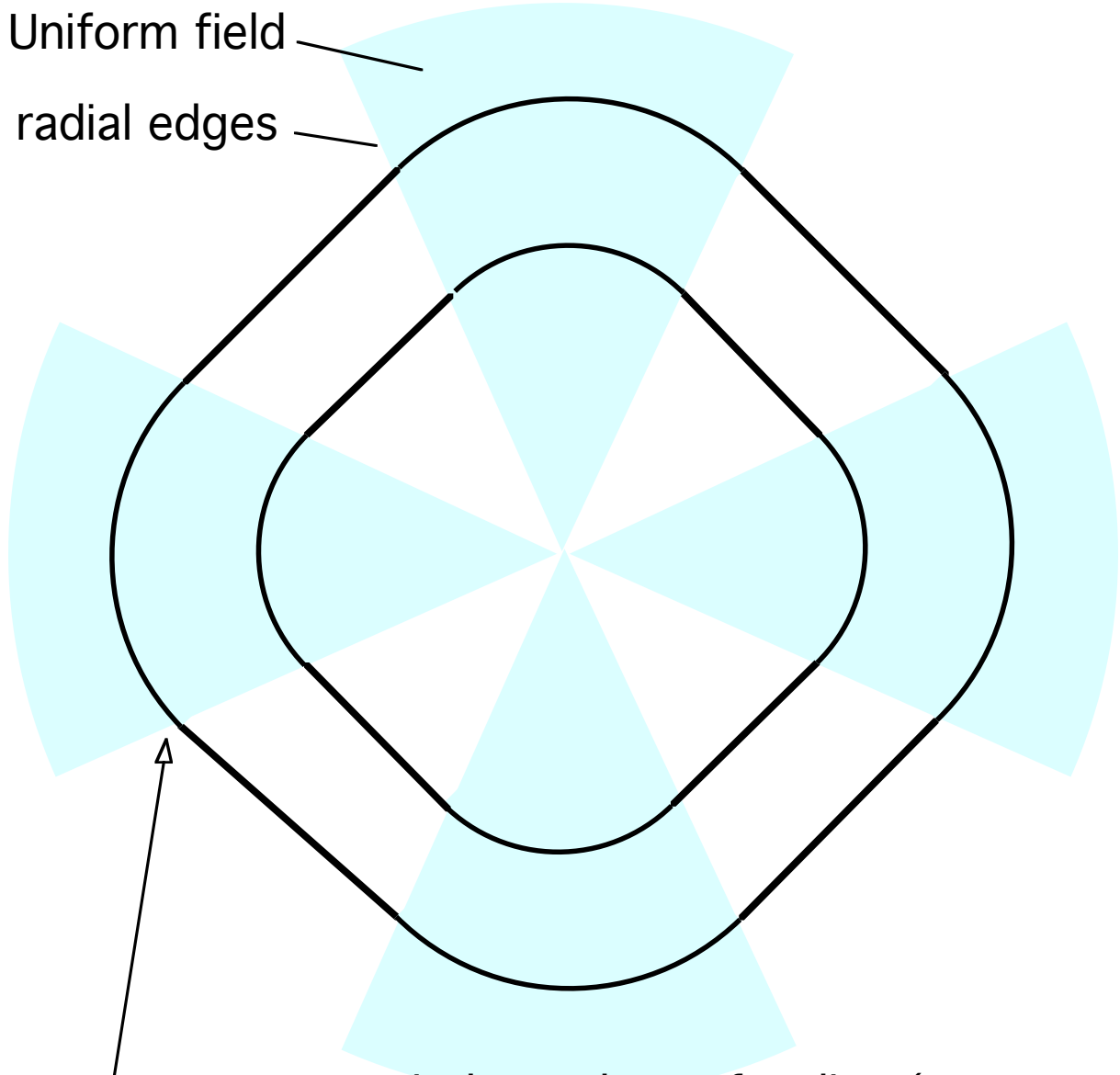
$\alpha = 1 / (1 - n)$

Following Courant & Snyder experts think this is a universal rule

If $\alpha = 1$, $Q_h = 1$

horizontal resonance

Experts say you cannot have $\alpha = 1$

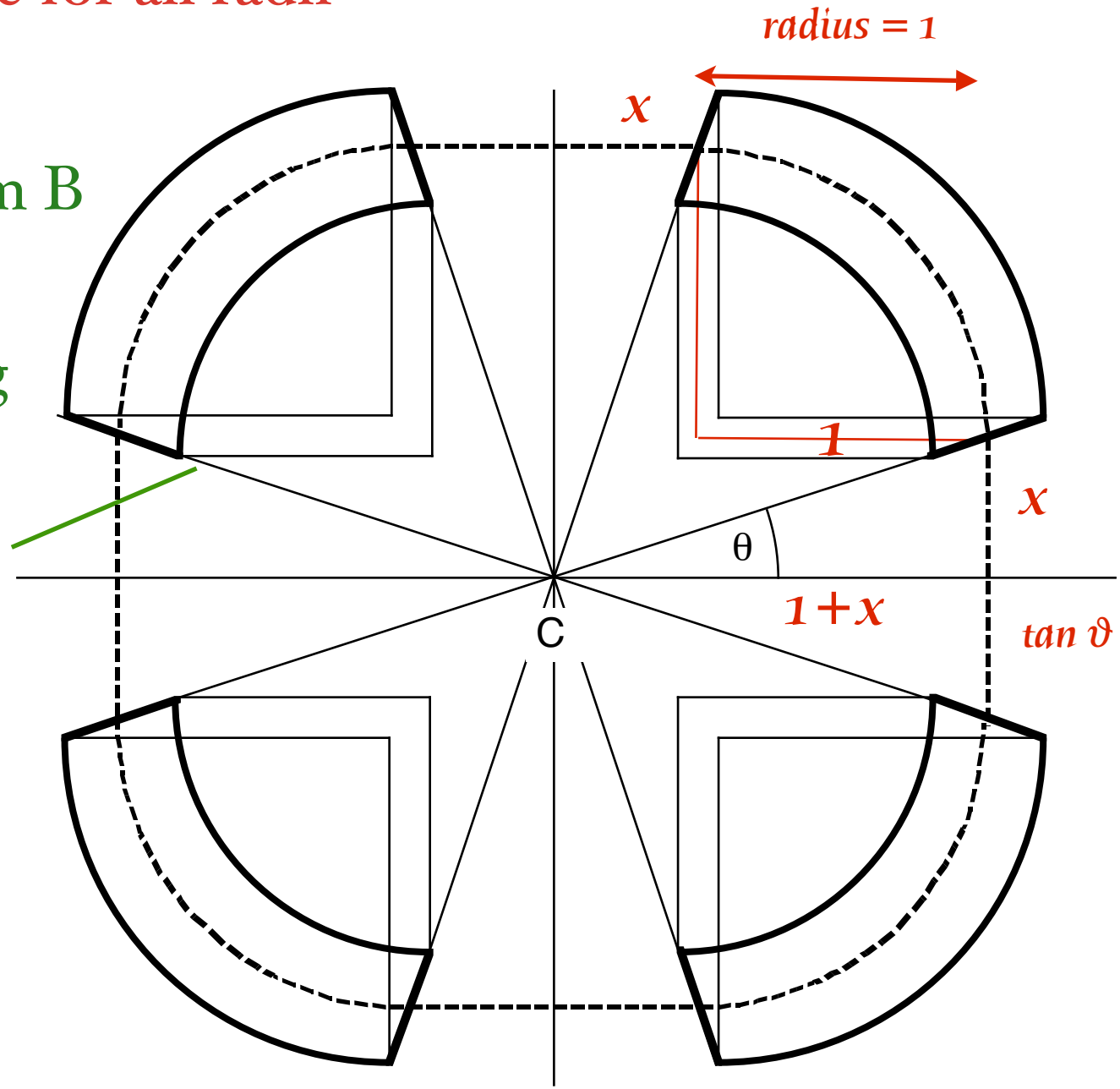

Uniform field
radial edges
<B> independent of radius (momentum)
Vertical focusing from magnet edges
Horizontal focusing from bends

<B> is same for all radii

uniform B

edge focusing

line extrapolates to center point



Calculate horizontal tune Q_h

ψ = *bend angle*
N=no. of sectors
$\psi = 2\pi/N$
$C=\cos\psi$
$S=\sin\psi$

$$\begin{vmatrix} 1 & 2x \\ 0 & 1 \end{vmatrix}$$

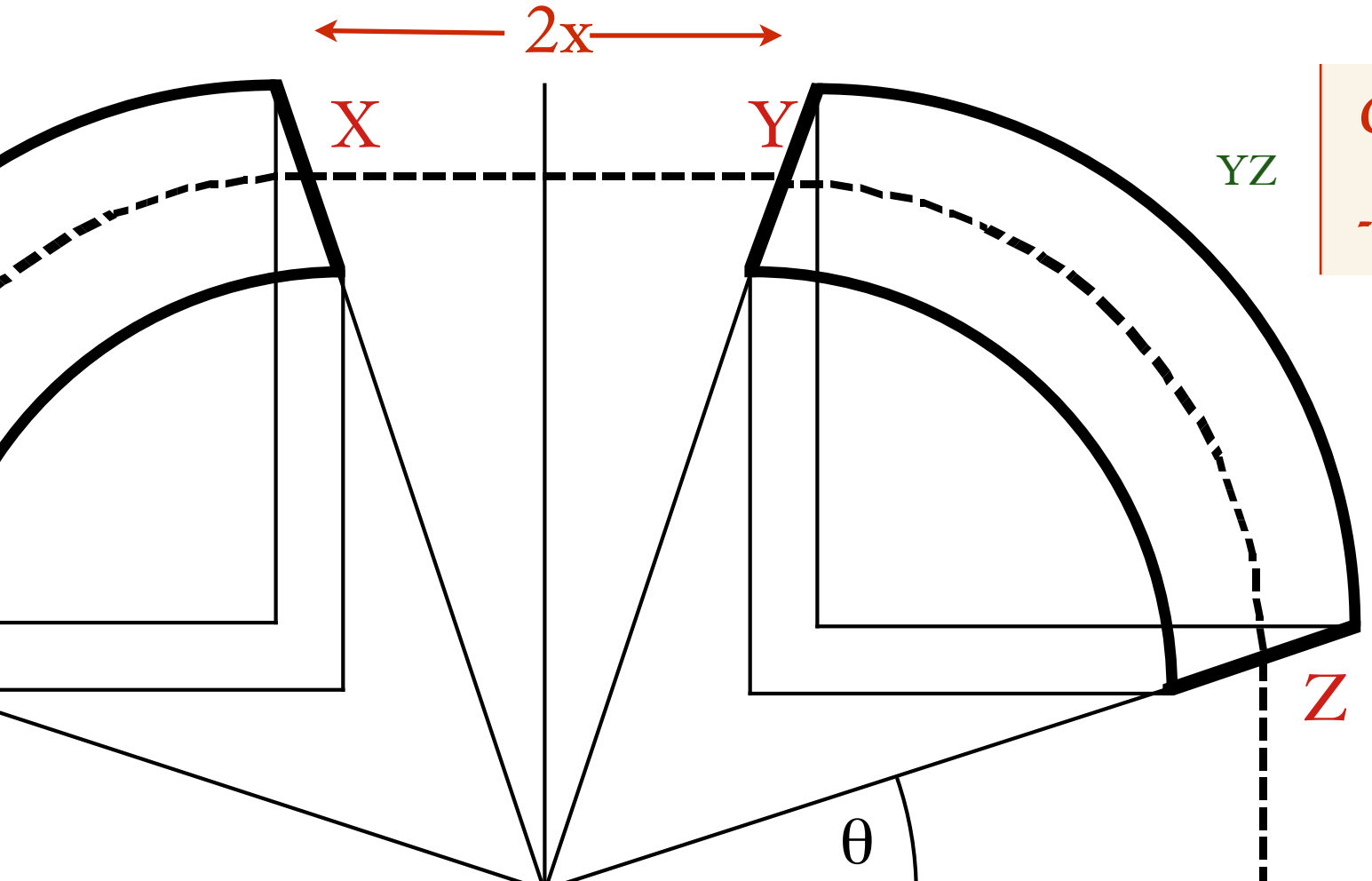
XY

$$\begin{vmatrix} 1 & 0 \\ T & 1 \end{vmatrix}$$

Y

Air gap 2x is uniquely related to edge angle θ

$T=\tan\theta = x/\{1+x.\cot(\psi/2)\}$



YZ

$$\begin{vmatrix} C & S \\ -S & C \end{vmatrix}$$

$$\begin{vmatrix} 1 & 0 \\ T & 1 \end{vmatrix}$$

Z

$$\cos(Q_h\psi) = \text{half the trace of the matrix for one sector}$$

$$= C + ST + x\{2CT + S(T^2-1)\}$$

$$\cos(Q_v\psi) = \text{half the trace of the matrix for one sector}$$

$$= \{1 - Tz - 2T^2\}\{1 - \psi T/(1 - Tz)\}$$

ψ = bend angle

N = no. of sectors

$\psi = 2\pi/N$

$C = \cos\psi$

$S = \sin\psi$

$T = \tan\theta = x/\{1+x.\cot(\psi/2)\}$

Air gap $2x$ is uniquely related to edge angle θ

Q vs open wedge angle for 4 sector ring

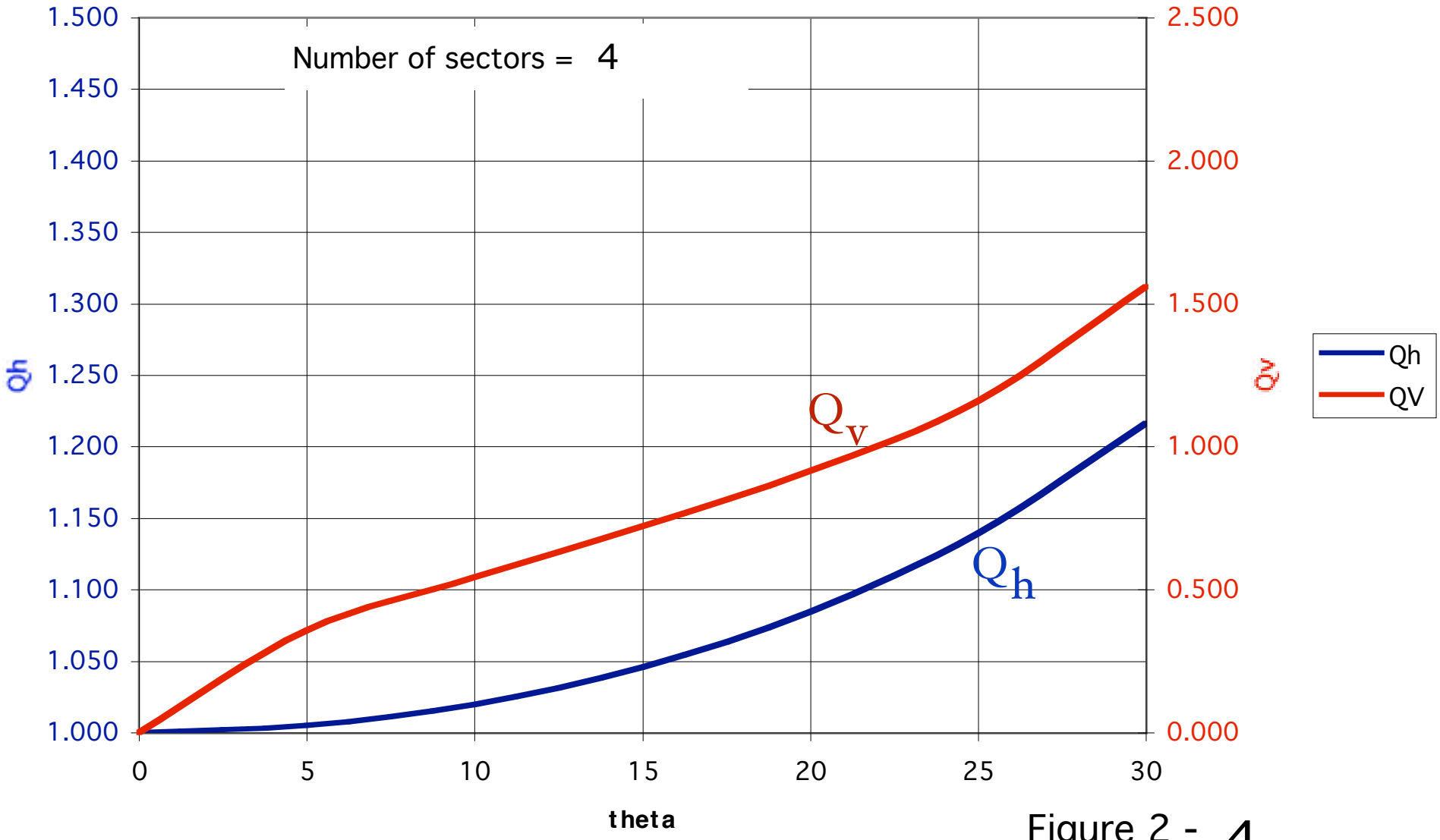


Figure 2 - 4

Q vs open wedge angle for 3 sector ring

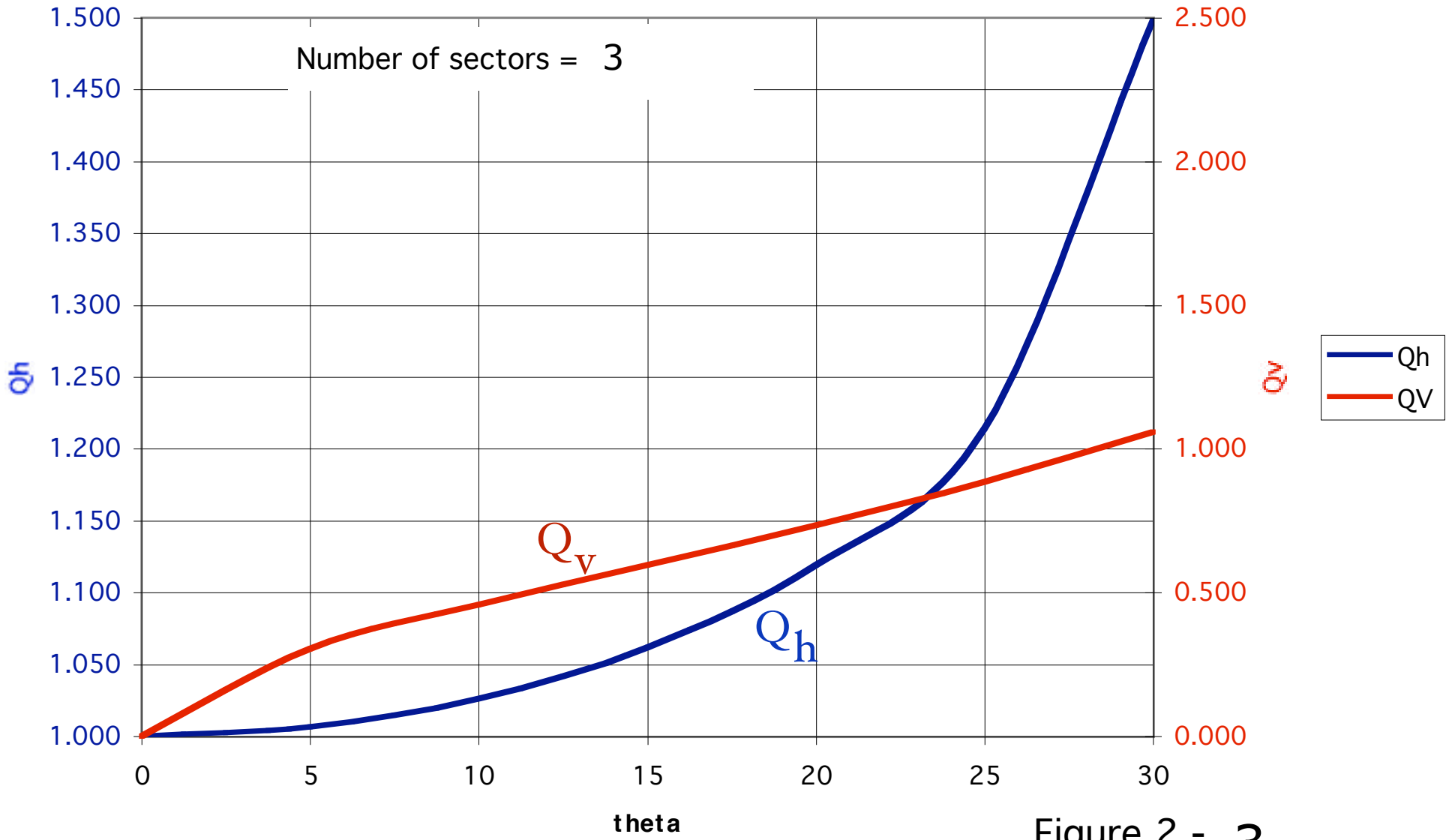


Figure 2 - 3

Two bends ..... system is unstable horizontally

With 3 bends

$Q_v = 0.82$ $\theta = 22.875$ $Q_h = 1.167$

Resonance search

None found, except $6\ Q_h = 7.002$

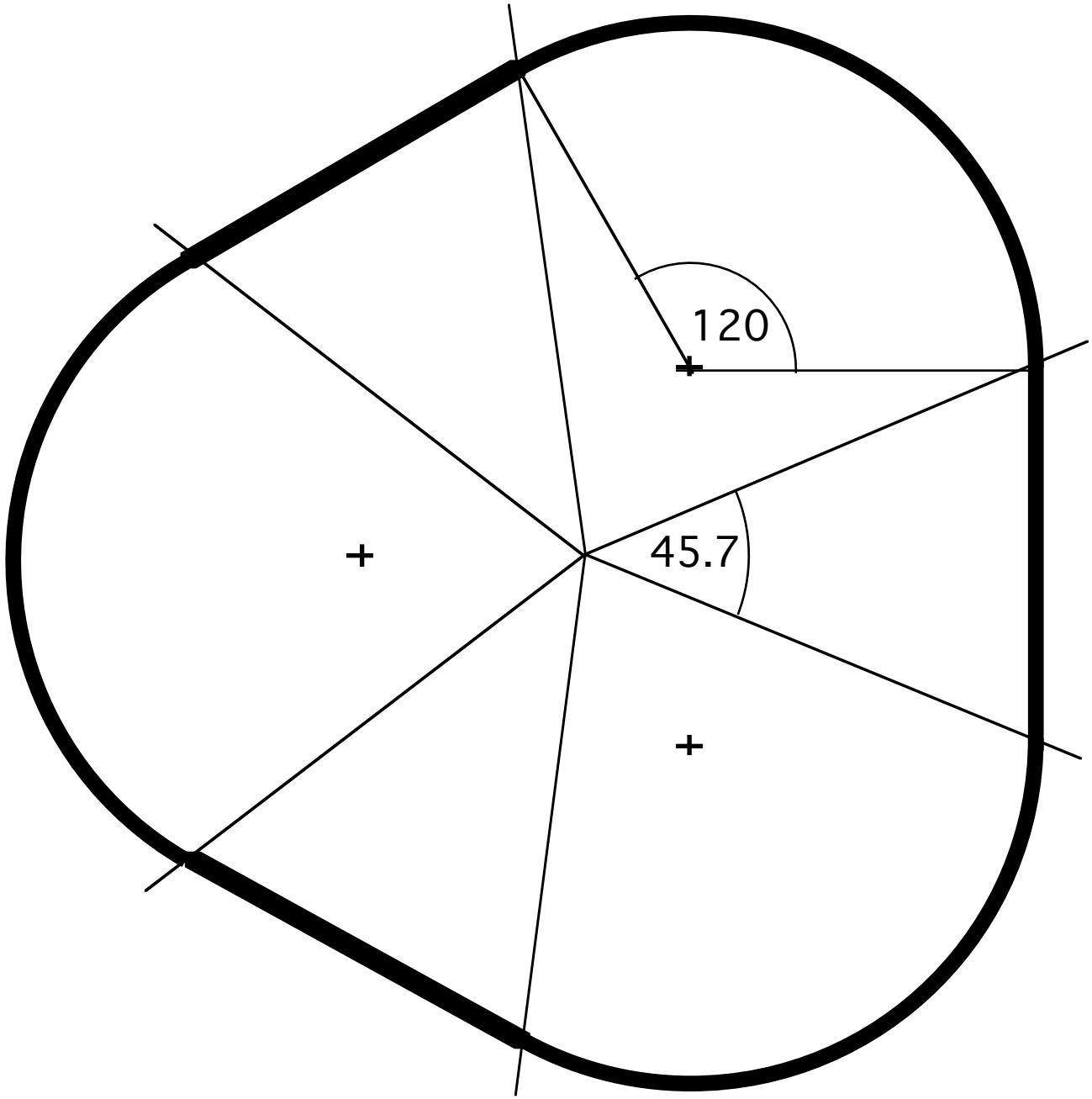
EDM ring

$\alpha = 1.000$

$Q_v = 0.82$

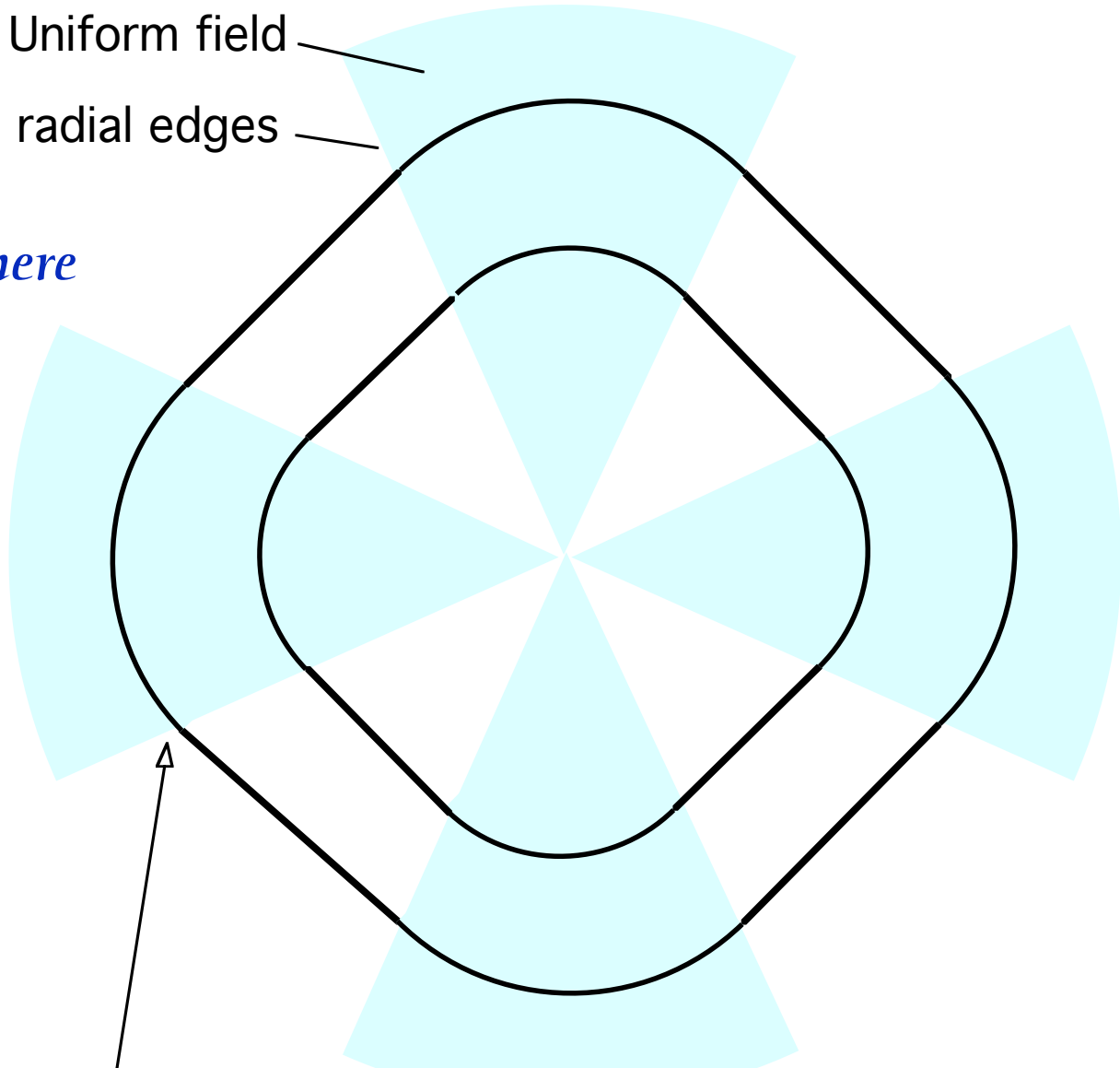
$Q_h = 1.167$

$\theta = 22.875$



Want dispersion D = o

dR/dp is same everywhere



Add quads to make cross-over in straight section